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See the attached Examiner's Answer.

Commissioner for Patents

LUZ ALEJANDRO-MULERO
PRIMARY EXAMINER

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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 09/611,037
Filing Date: July 06, 2000
Appellant(s): KUTHI ET AL.

Rick von Wohld
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 3/7/05 and 9/15/05 appealing from the Office action mailed 9/2/04.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The following are the related appeals, interferences, and judicial proceedings known to the examiner which may be related to, directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal:

10/796,836

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

5,593,540	TOMITA ET AL.	01-1997
4,854,263	CHANG ET AL.	08-1989

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to

consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 33-35, 37-38, and 40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tomita et al., U.S. Patent 5,593,540 in view of Admitted prior art.

Tomita et al. shows the invention substantially as claimed including in a chamber 1 for processing a semiconductor wafer W through plasma etching operations, the chamber being in an operational state and including a support chuck 61 for holding the semiconductor wafer, a RF power supply 12 for an upper electrode 3, a method of processing the wafer through plasma etching operations, comprising: striking a plasma in the plasma region in the chamber; and generating an increase in bias voltage/ion bombardment energy directed at a wafer surface of a semiconductor wafer W and a decrease in bias voltage directed at the top electrode 2, the top electrode 3 having a center region, a first surface, and a second surface, the first surface having an inlet 55 that is configured to receive processing gases from a source (71a,71b,71c) that is external to the chamber and facing a cooling plate 53 and flowing processing gases into the center region; the second surface facing the interior portion of the plasma chamber and having a plurality of gas feed line holes 55 that lead to a plurality of electrode openings which expose the gas to the plasma, wherein when a plasma is struck in the plasma region defined between the second surface and the wafer surface, the plasma defines a first plasma sheath surface having a first plasma sheath surface area that is proximate to the wafer surface and a second plasma sheath surface area that is proximate to the second surface, the second plasma sheath surface area being greater

than the first plasma sheath surface area (see figs. 1-4 and col. 3-line 40 to col. 5-line 60). Note that inherently the plasma sheath will form within the inlet openings 55 to form the second plasma sheath surface area since the openings have an opening diameter of 0.6mm (see applicant's specification at page 13, lines 22-24 and col. 5-lines 3-5 of Tomita et al.).

Tomita et al. fails to expressly disclose a pair of RF power sources. With respect to the dual RF power sources, admitted prior art in fig. 1A discloses a first RF power source 118b connected to a lower electrode and a second RF power source 118a connected to an upper electrode (see fig. 1A and page 1-line 24 to page 2-line 16 of specification). In view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Tomita et al. so as to include two RF power sources coupled to the upper and lower electrodes, respectively, because the Admitted prior art shows this to be a suitable structure for a plasma etching apparatus.

Claims 14-21 and 33-40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Admitted prior art (APA) in view of Chang et al., U.S. Patent 4,854,263.

APA shows the invention substantially as claimed including in a chamber 102 for processing a semiconductor wafer through plasma etching operations, the chamber being in an operational state and including a support chuck 104 for holding the wafer, a pair of RF power sources 118a/118b, and a top electrode 114, a method for processing

the wafer through plasma etching operations, comprising: striking a plasma in a plasma region of the chamber; the top electrode having a center region, a first surface and a second surface, the first surface having an inlet that is configured to receive processing gases from a source that is external to the chamber and flow the processing gases into the center region, the second surface having a plurality of gas feed holes/electrode openings, wherein the plurality of electrode openings are configured to define the second surface which is located over the wafer surface of the semiconductor wafer, wherein the plasma is struck in the plasma region defined between the second surface and the wafer surface, the plasma defines a first plasma sheath surface having a first plasma sheath surface area that is proximate to the wafer surface and a second plasma sheath having a second plasma sheath surface area that is proximate to the second surface (see, figs. 1A-1C of the APA and their descriptions).

The admitted prior art does not expressly disclose that the electrode openings diameter is greater than the gas feed holes diameter. Chang et al. an electrode which has been formed so as to comprise gas feed holes 33 that lead to a plurality of electrode openings 31/34, the electrode openings having diameters that are greater than gas feed hole diameters of the plurality of gas feed holes in order to enhance dissociation and reactivity of the gas(es) (see col. 5-lines 33-53 and figs. 1-3). Therefore, in view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the APA as to comprise electrode openings having diameters that are greater than gas feed hole diameters of the plurality of gas feed openings because this would enhance dissociation and

reactivity of the gas(es). Additionally, in teachings of the APA modified by Chang et al.: a) the second plasma sheath surface area will be greater than the first plasma sheath surface area (since the plasma sheath will form within the inlet openings, note that the openings diameter is more than 0.5mm, also see applicant's specification at page 13, lines 22-24 and col. 6-lines 24-26 of Chang et al.), which will generate an increase in bias voltage and ion bombardment energy directed at a wafer surface of the wafer and a decrease in bias voltage directed at the top electrode, and b) plasma sheath will shift into the electrode openings of the top electrode. Note that with respect to claims 33-40, the above first plasma sheath surface area will be the second plasma sheath surface area and the above second plasma sheath surface area will be the first plasma sheath surface area.

With respect to claim 15, note that the top electrode is coupled to one of the pair of RF power sources and the support chuck is coupled to the other one of the pair of RF power sources.

Concerning claims 16-17 and 20, APA and Chang do not disclose that the gas feed holes have a diameter of about 0.1mm, the electrode openings have a depth of 1/32 to ¼ of an inch, and fixing a separation between the second plasma sheath surface having the second plasma sheath surface area and the second surface of the top electrode at about 0.5 to 5mm, but it would have been obvious to one of ordinary skill in the art at the time the invention was made to optimize through routine experimentation the gas feed hole diameter, the electrode opening depth, and the spacing of the second plasma sheath surface from the second surface depending upon, for example, the

particular size of the semiconductor being processed, and therefore the claimed dimensions would not lend patentability to the claimed invention absent the showing of unexpected results.

Regarding claim 18, note that electrode 114 of APA is movable in the vertical direction and Chang et al. discloses such separation dimension. Therefore, it would have been obvious to it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the separation of the second surface and the wafer surface, as claimed, depending upon, for example, the desired plasma density, and therefore the claimed dimensions would not lend patentability to the claimed invention absent the showing of unexpected results. Additionally,

With respect to claim 19, note that two or more buffer plates are inserted within the center region of the top electrode (see fig. 1B).

Claims 14-21 and 33-40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chang et al., U.S. Patent 4,854,263 in view of Admitted prior art (APA).

Chang et al. shows the invention substantially as claimed including in a chamber 10 for processing a semiconductor wafer through plasma etching operations, the chamber being in an operational state and including a holder for holding the wafer, a RF power, and a top electrode 11, a method for processing the wafer through plasma etching operations, comprising: striking a plasma in a plasma region of the chamber; the top electrode having a center region, a first surface and a second surface, the first

surface having an inlet that is configured to receive processing gases from a source that is external to the chamber and flow the processing gases into the center region, the second surface having a plurality of gas feed holes 33 that lead to a plurality of electrode openings 31/34 that have diameters greater than gas feed hole diameters, wherein the plurality of electrode openings are configured to define the second surface which is located over the wafer surface of the semiconductor wafer, wherein the plasma is struck in the plasma region defined between the second surface and the wafer surface, the plasma defines a first plasma sheath surface having a first plasma sheath surface area that is proximate to the wafer surface and a second plasma sheath having a second plasma sheath surface area that is proximate to the second surface (see figs. 1-3, col. 4, lines 60-64, and col. 5-lines 33-53). Furthermore note that: a) the second plasma sheath surface area will be greater than the first plasma sheath surface area (since the plasma sheath will form within the inlet openings, note that the openings diameter is more than 0.5mm, also see applicant's specification at page 13, lines 22-24 and col. 6-lines 24-26 of Chang et al.), which will generate an increase in bias voltage and ion bombardment energy directed at a wafer surface of the wafer and a decrease in bias voltage directed at the top electrode, and b) plasma sheath will shift into the electrode openings of the top electrode. Note that with respect to claims 33-40, the above first plasma sheath surface area will be the second plasma sheath surface area and the above second plasma sheath surface area will be the first plasma sheath surface area.

Chang et al. does not expressly disclose holding the substrate with a chuck, the use of a pair of power sources, and inserting two or more gas buffer plates within the center region of the top electrode. APA discloses holding the wafer 106 with a chuck 104, coupling a pair of RF power sources 118a/118b to the top electrode and the chuck, and inserting two or more buffer plates within the center region of the top electrode (see, figs. 1A and 1B, and their descriptions). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the teachings of Chang et al. by holding the wafer with a chuck and by coupling RF power to the chuck in order to efficiently and effectively hold the wafer during processing, in order to generate a bias voltage within the plasma region, and in order to evenly distribute the processing gases throughout the top electrode, respectively, thereby increasing the ion bombardment towards the substrate and improving the process being perform on the substrate.

Concerning claims 16-17 and 20, Chang et al. and APA do not disclose that the gas feed holes have a diameter of about 0.1mm, the electrode openings have a depth of 1/32 to ¼ of an inch, and fixing a separation between the second plasma sheath surface having the second plasma sheath surface area and the second surface of the top electrode at about 0.5 to 5mm, but it would have been obvious to one of ordinary skill in the art at the time the invention was made to optimize through routine experimentation the gas feed hole diameter, the electrode opening depth, and the spacing of the second plasma sheath surface from the second surface depending upon, for example, the particular size of the semiconductor being processed, and therefore the

claimed dimensions would not lend patentability to the claimed invention absent the showing of unexpected results.

Regarding claim 18, note that Chang et al. discloses an electrode separation within the claimed dimension range.

(10) Response to Argument

Appellant's arguments filed 3/7/05 and 9/17/05 have been fully considered but are not deemed persuasive. The examiner acknowledges appellant's incorporation of the appeal brief filed on 3/7/05 into the appeal brief of 9/17/05.

Appellant argues that: a) the structure of Tomita et al. does not inherently cause a shift of the plasma sheath into electrode openings and the electrode size parameter of the Tomita et al. reference does not teach or suggest the method that Applicants claimed (see argument A in the appeal brief of 9/17/05); b) "The size of the electrode openings is but one parameter or feature of the presently claimed method. It is not a valid assumption to conclude that any electrode having electrode openings of a particular size (in the instant application the size is recited to be at least 0.5mm) will result in a plasma shift into the electrode openings." (see argument B of the appeal brief filed 3/7/05), and c) "The fact that the electrode openings (55b) of Tomita et al. may be 0.6 mm, does not support that plasma formed adjacent to that electrode will inherently shift into the electrode openings as claimed by Applicants." (see argument B of the appeal brief filed 3/7/05). However, the examiner submits that disclosures both in applicant's own specification (see, for example, the last three lines of page 13 of the

specification that establish a clear relationship between the size of the openings and the plasma sheath present within the openings) and in the Tomita et al. reference (the discussion of polymerization, which is a result of plasma formation, at col. 2-lines 37-53) establish the case of inherency, since both Tomita et al. and the instant application disclose hole sizes which allow for the shifting of a plasma sheath therein. As stated in the previous and above rejections, the specification of the instant claimed invention (see applicant's specification at page 13, lines 22-24), as well as the declaration filed under 37 CFR 1.132, clearly states that the plasma sheath will form within openings having at least 0.5mm, therefore, note that inherently the plasma sheath will form within the inlet openings 55, of the Tomita et al. reference, to form the second plasma sheath surface area since the openings have an opening diameter of 0.6mm (see col. 5-lines 3-5 of Tomita et al.).

Appellants argue that the Tomita et al. reference teaches suppressing polymerization in the openings of the gas feed holes and therefore plasma sheath is not formed in the openings of the gas feed holes (see argument A in the appeal brief of 9/17/05). However, the examiner respectfully points out that it is clear that the use of the word "suppressed" implies that while not as much plasma will be present in the holes than in the prior art due to the flow rate of the gas, some plasma will still be present (see col. 2-lines 37-53). The fact that a feature is inherent or not in a reference is clearly distinct from whether the feature is desired.

Appellants argue that the term "shifting" is and must be read in light of Appellant's disclosure, which makes clear that it is not simply "incidental" (see argument

A in the appeal brief of 9/17/05). However, it should be noted that appellant's method of "shifting" the plasma sheath into the openings of the gas feed holes is by providing gas feed holes having openings with a diameter of at least 0.5 mm. The examiner respectfully submits that there is no patentable difference in the use of the word "shifting" in the claimed method of the instant invention and the method disclosed by the Tomita et al. reference in which a plasma sheath will inherently "shift" into the openings of the gas feed holes.

Regarding appellant's argument that Tomita et al. does not show the gas feed holes smaller than the electrode openings (see argument B of the appeal brief filed 3/7/05), note that the features upon which applicant relies (i.e., the gas feed holes smaller than the electrode openings) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

Concerning appellant's argument with respect to section B of the appeal brief filed 9/17/05, appellant argues that the Admitted Prior Art (APA) and Chang et al. reference do not teach the claimed plasma sheath formation. However, the examiner submits that disclosures both in applicant's own specification (see, for example, the last three lines of page 13 of the specification that establish a clear relationship between the size of the openings and the plasma sheath present within the openings) and in the Chang et al. reference establish the case of inherency, since both Chang et al. and the instant application disclose hole sizes which allow for the shifting of a plasma sheath

therein. As stated in the previous and above rejections, the specification of the instant claimed invention (see applicant's specification at page 13, lines 22-24), as well as the declaration filed under 37 CFR 1.132, clearly states that the plasma sheath will form within openings having at least 0.5mm. Therefore, note that inherently the plasma sheath will form within the inlet openings 31/34 of the Chang et al. reference, since the openings have an opening diameter greater than 0.5mm, see col. 6-lines 24-26 of Chang et al., wherein an opening having a diameter of 190 mils (4.82mm) is disclosed. Note that such diameter is within the preferred range of 2-10mm for the diameter of the openings of the gas feed hole, as disclosed in paragraph 5 of the declaration under 37 CFR 1.132 (see Appendix B).

With respect to the declaration under 37 CFR 1.132, it should be noted that: a) in paragraph 2 of the declaration the following is stated with respect to the Tomita et al. reference "To achieve a mass flow speed...the holes in the showerhead must be smaller than 0.6mm. The reference specifies 0.6mm as the maximum diameter of the hole.", the examiner respectfully disagrees with such a statement since in col. 2, lines 30-34, of Tomita et al., it is clearly stated that the hole diameters should be smaller than 0.8mm, not 0.6mm as mistakenly stated by appellant; b) in paragraph 3 of the declaration, it is stated that the holes in the claimed invention must be big enough to allow plasma to exist inside, and then in paragraph 4 of the declaration, it is stated that a hole having a diameter larger than 0.5 mm will meet the requirement for a hole size; therefore, the prior art of record clearly meets the dimensions for the diameter of the openings; and c) at the end of paragraph 5 of the declaration, it is stated that "For most

of our applications, we prefer diameter of showerhead holes to be 2 ~ 10mm.", however, it is respectfully noted that the claims of the instant invention does not recite such hole dimension.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

Luz L. Alejandro

Conferees:

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